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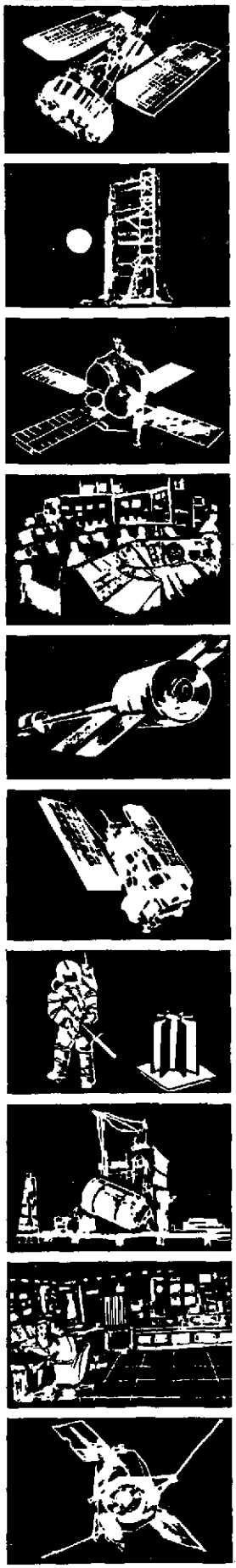

EARTH OBSERVATORY SATELLITE SYSTEM DEFINITION STUDY

Report No. 5
SYSTEM DESIGN AND SPECIFICATIONS

Volume 5
SPECIFICATION FOR EOS OPERATIONS CONTROL CENTER

Prepared for:
GODDARD SPACE FLIGHT CENTER
Greenbelt, Maryland 20771

Under
Contract No. NAS 5-20518

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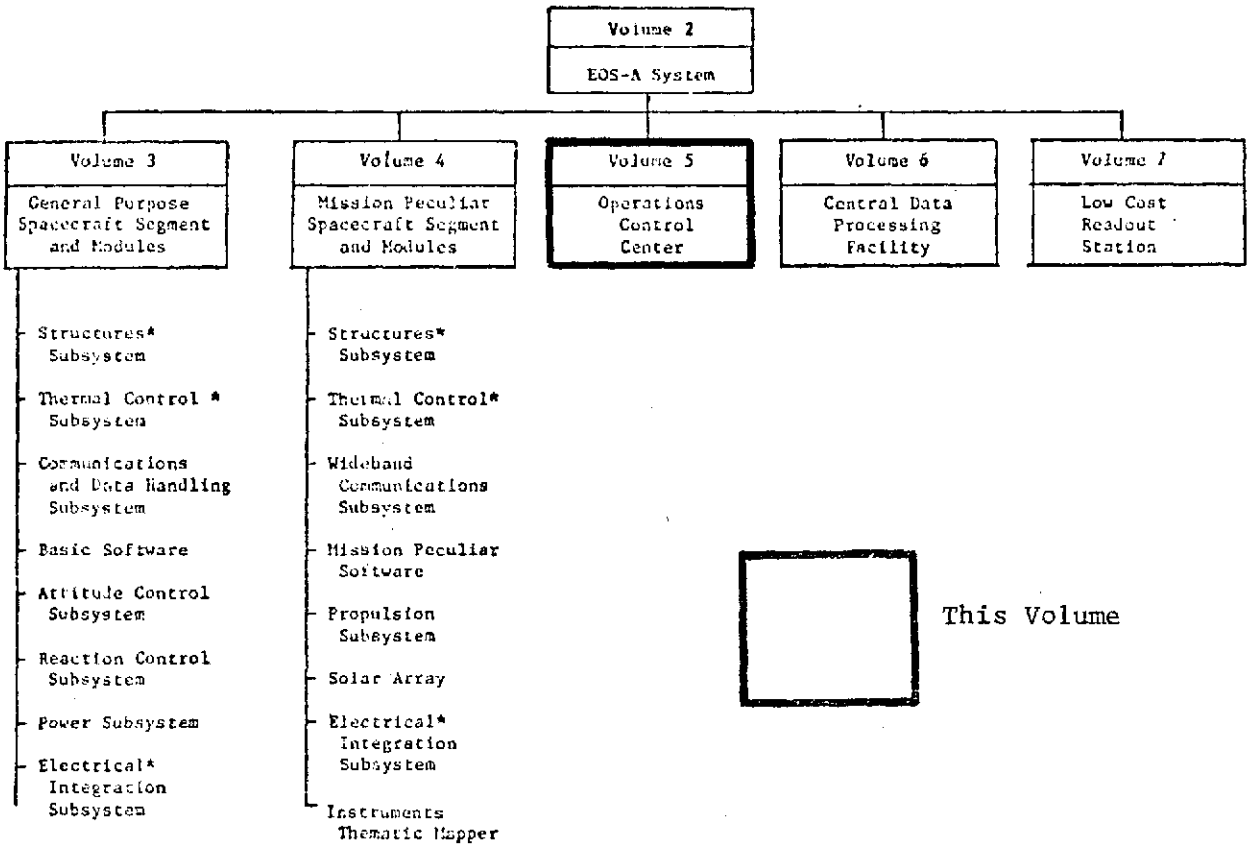
PREFACE

This report, "Baseline System Design & Specifications", has been prepared for NASA/GSFC under contract NAS 5-20518 EOS System Definition Study. It describes the system design that has evolved through a series of design/cost tradeoffs to satisfy a spectrum of mission/system requirements. The basic spacecraft design is compatible with many missions. The EOS-A mission, the potential first mission, is used to define the mission peculiar elements of the system.

For convenience this report is bound in separate volumes as follows:

Volume 1	Baseline System Description
Volume 2	EOS-A System Specification
Volume 3	General Purpose Spacecraft Segment and Module Specifications
Volume 4	Mission Peculiar Spacecraft Segment Specification
Volume 5	Operations Control Center Specification
Volume 6	Central Data Processing Facility Specification
Volume 7	Low Cost Ground Station Specification

Volume 1 "Baseline System Description" presents the overall EOS-A system design, a description of each subsystem for the spacecraft, and the major ground system elements. Volumes 2 through 7 present the specifications for the various elements of the EOS system and are organized according to the specification tree as follows:



* These specifications are written as integral specifications for the GPSS and MPSS and appear in Volume 3 only.

SPECIFICATION #SVS-XXXX
16 SEPTEMBER 1974

SPECIFICATION

FOR THE

EARTH OBSERVATORY SATELLITE (EOS)

OPERATIONS CONTROL CENTER (OCC)

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SECTION 1.0

SCOPE

This specification establishes the performance, design, development and test requirements for the Earth Observatory Satellite Operations Control Center (OCC).

SECTION 2.0

APPLICABLE DOCUMENTS

The following documents form a part of, or are related to, this specification.

2.1 SPECIFICATIONS

2.1.1 NASA GODDARD SPACE FLIGHT CENTER (GSFC) SPECIFICATIONS

S-323-P-5A	Quality Assurance Requirements for Standard Industrial Equipment
(TBR)	Earth Observatory Satellite System Specification

2.1.2 GENERAL ELECTRICAL COMPANY SPECIFICATIONS

(TBR)	OCC Communications and Data Distribution Subsystem
(TBR)	OCC Status Control and Display Subsystem
(TBR)	OCC Computing Services Subsystem
(TBR)	GDHS Grounding Requirements Specification

2.2 OTHER PUBLICATIONS

2.2.1 OTHER GENERAL ELECTRIC COMPANY DOCUMENTS

(TBR)	CDPF/OCC Interface Control Document
(TBR)	NASCOM/OCC Interface Control Document
(TBR)	NTTR/OCC Interface Control Document
(TBR)	TDRSS/OCC Interface Control Document
(TBR)	Space Shuttle OCC/OCC Interface Control Document
(TBR)	GDHS Communications and Data Equipment and Installation Requirements Interface Control Document
(TBR)	GDHS/ODG Interface Control Document
(TBR)	OCC/GSFC Timing Data and Reference Signals Interface Control Document
(TBR)	GDHS/GSFC Facility Interface Control Document

(TBR) OCC/LCRS Interface Control Document

(TBR) OCC/Prime International Readout Stations Interface Control Document

(TBR) EOS Data Format Control Book

(TBR) MSS Interface Agreement

(TBR) TM Interface Agreement

(TBR) HRPI Interface Agreement

(TBR) GDHS Reliability/Maintainability Program Plan

(TBR) GDHS Quality Assurance Program Plan

2.2.2 NASA REQUIREMENTS DOCUMENTS

(TBR) EOS-A/B Support Instrumentation Requirements Document (SIRD)

2.2.3 MISCELLANEOUS

(TBR) Computer Interface Design Manual (dependent on particular computer chosen for the OCC)

SECTION 3

REQUIREMENTS

The functional, performance, and design requirements of the EOS OCC are specified in this section.

3.1 OCC SEGMENT DEFINITION

3.1.1 GENERAL REQUIREMENTS

The OCC shall control operations of the EOS spacecrafts to acquire mission data consisting of:

(1) Thematic Mapper (TM) data

(2) Multispectral Scanner (MSS) data on EOS-A, or High Resolution Pointable Imager (HRPI) data on EOS-B

(3) Data Collection System (DCS) data

The OCC shall be capable of operating the EOS observatories to acquire mission data at every opportunity over the continental United States, and of scheduling additional payload operation over any other earth land masses.

Inputs to the OCC shall consist of the following:

(1) Spacecraft telemetry data (including Data Collection System (DCS) data) via the Spaceflight Tracking and Data Network (STDN)

(2) Voice and teletype communications from network stations

(3) System Scheduler outputs from the Data Management Element (DME) describing a time sequence of all payload activities.

(4) Ground control point information, calibration data, and predicted video data from the DME formatted for transmission to the spacecraft to be included in the video data

(5) Orbital data including predicted station contact profiles and predicted spacecraft antenna contact profiles from the Orbit Determination Group via the DME.

Utilizing the above-specified inputs, the OCC shall provide the following major outputs:

(1) Commands for controlling the spacecrafts via STDN

(2) Ground point, ephemeris, calibration, predicted video, and other auxiliary data to be transmitted to the spacecrafts via STDN

(3) Spacecraft and ground station configuration and status to the DME as input for the System Scheduler

(4) Spacecraft coverage data and status data to the DME

(5) DCS data to be used by the DME in generating DCS products

(6) Spacecraft acquisition data to Low Cost Readout Stations and International Readout Stations.

3.1.2 FUNCTIONS

The OCC shall satisfy the following six major functional requirements:

(1) Spacecraft command and control

(2) Spacecraft telemetry retrieval and processing

(3) Spacecraft health and status

(4) Activity planning and command generation

(5) Remote station contact scheduling

(6) Display and report generation

3.1.2.1 Spacecraft Command and Control

This function provides the spacecraft managers with the methods to control and manage the spacecrafts effectively and efficiently. The managers shall utilize the data processing equipment and other associated hardware to:

- specify commands
- uplink and verify commands
- receive and process downlink telemetry for real-time display
- check and/or modify memory contents of on-board processor

- o perform functions necessary to ensure satisfactory spacecraft and subsystems performance

3.1.2.2 Telemetry Retrieval and Processing

After telemetry data is received at the NASCOM station it shall be transmitted to the OCC via a communications modem. This communications modem will interface with the Signal Conditioning and Switching Unit (SCASU) of the Communications and Data Distribution Subsystem.

The telemetry data streams -- real-time or recorder playback -- shall be output from the SCASU through the computer interface to the OCC computers which shall process the data for output to various computer peripherals. Data shall be stored on a disc, output to a plotter interface for plotting, and distributed to the Status Control and Display Subsystem interface.

The disc storage shall be used as an input/output medium to the OCC computers and shall provide inputs to the DME for further data processing and distribution.

Processed data flow to the Status Control and Display interface shall be maintained for distribution to the various OCC CRT display units. These CRT display units shall have the capability of multi-page call-up to provide access to all telemetry data functions for spacecraft and payload status evaluation.

The same data link used for processed data shall be utilized for pre-pass and post-pass orbit operations and evaluation.

3.1.2.3 Spacecraft Health and Status

Telemetry data received from the spacecrafts shall be processed during each station pass in real-time and near real-time to provide "quick-look" displays

of spacecraft health and status. Additional on-line and off-line processing shall be performed post-pass to provide in-depth analyses of spacecraft health, performance, and trends.

3.1.2.4 Activity Planning and Command Generation

The OCC shall perform the activity planning and command generation necessary to fulfill the overall mission schedules .

Included within the OCC activity planning activities shall be the spacecraft antenna pointing function. The OCC shall be responsible for accepting, via the DME, the predicted antenna contact profiles for acquiring the three prime EOS ground-site stations and the International Stations with the X-Band pointable antennas and the predicted antenna contact profile for acquiring the TDRS with the TDRS antenna.

The spacecraft command generation software shall utilize scheduling information from the DME to generate both real-time and stored command sequences that satisfy the requested mission for upcoming orbits. The software shall be capable to accept updates and insertions for inclusion into the sequences to allow project management to make mission changes as required.

The OCC shall generate the commands necessary to operate the spacecrafts as follows:

- Compile commands which satisfy the mission activity plan within spacecraft system performance and configuration constraints.
- Display and verify commands before transmission to ensure that the command list is correct and does not violate prescribed operational procedures.

- o Block and format commands and transmit via the appropriate support network.
- o Verify command execution in the spacecrafts for both real-time and stored commands.

3.1.2.5 Remote Station Contact Scheduling

This function involves the scheduling and control of the remote stations during each spacecraft pass. These activities shall be performed prior to and during the pass through communication from the operations supervisor who shall establish the data link setup to and from the OCC. Included in this function are remote station instructions for video data dissemination.

3.1.2.6 Display and Report Generation

The OCC computers shall generate detailed displays and reports which provide clear and precise information on the status of the spacecrafts and their subsystems to be used for extensive performance evaluation. Quick-look and overall status data shall be displayed on the CRT's of the operations consoles. Results of detailed post-pass analyses shall be output as in-depth printer reports. An X-Y plotter shall be utilized for long-term spacecraft subsystem performance trend analysis.

3.1.3 INTERFACE DEFINITION

The major Operations Control Center interfaces shall be with the Central Data Processing Facility (CDPF) and with the Spaceflight Tracking and Data Network (STDN). Other OCC interfaces shall include the Goddard Space Flight Center (GSFC) and NASA Communication Facility.

3.1.3.1 Central Data Processing Facility

The OCC shall interface with the Data Management Element of the Central Data Processing Facility via a shared random-access mass-storage disc.

3.1.3.1.1 Data Management Element

The primary Data Management Element (DME) interfaces with the OCC shall be:

(a) DME-created "Sensor Scheduling File" which provides the OCC with a time sequenced list of payload schedule activities and orbital data for each satellite for each pass.

(b) DME-created "GCP Data File" which provides the OCC with instrument data processing information (geometric, radiometric and Ground Control Point data) for formatting and transmission to the spacecrafts via STDN.

(c) OCC-created "S/C Performance Data File" which provides to the DME the actual spacecraft and sensor performance data based on processed spacecraft telemetry data for scheduling of Image Processing Element products. In addition, this file will provide the DME with spacecraft and ground station configuration and status for the DME System Scheduler functions.

(d) OCC-created "DCS Data File" which provides the DME with processed DCS data for generation of DCS products by the DME.

The interface requirements between the DME and the OCC are defined in the OCC/CDPF Interface Control Document (ICD-TBR).

3.1.3.2 Spaceflight Tracking and Data Network

The Spaceflight Tracking and Data Network (STDN) shall provide the communication facilities for transferring the EOS mission operation data between the OCC and spacecrafts.

3.1.3.2.1 NASA Communication Network

The NASA Communication Network (NASCOM) shall provide the communication facility for transferring EOS spacecraft command and telemetry data between the OCC

and Ground-Site subnet, Tracking Data and Relay Satellite System subnet, and the Space Shuttle OCC.

The OCC shall interface directly with the NASCOM facilities consisting of the NASCOM 494 Communications Processor (CP), the X144 Terminal and modems. The OCC shall be capable of handling command and real-time PCM telemetry transfers with NASCOM simultaneously. All high speed data containing NASCOM block headers shall be routed through the 494 CP, at a 50 Kbps rate, formatted in 1200-bit blocks, and interfaced with the OCC by means of the duplex 50-Kbps type-303 modems.

The NASCOM/OCC interface equipment shall be GFE. The NASCOM/OCC interfaces are defined in the NASCOM/OCC Interface Control Document (ICD-TBR).

3.1.3.2.2 Ground-Site Subnet

The Ground-Site subnet shall provide the communication facilities for transferring EOS spacecraft command and telemetry data between NASCOM and the spacecrafts.

The primary ground-site subnet stations used to support the EOS mission shall include Alaska, Goldstone and the NASA Test and Training Facility (NTTF). Each of these stations shall have X-band and S-band capability for handling both payload and TI&C data. Merrit Island, Rosman, Madrid and Orroral stations shall provide backup support capability.

A. Alaska

The OCC shall transmit spacecraft commands to Alaska and receive command verification data from Alaska via the NASCOM 494CP. The OCC shall receive the real-time PCM telemetry data via the NASCOM 494CP and the dump PCM telemetry and dump on-board computer data via the GSFC X-144 data transmission terminal.

B. Goldstone

The OCC shall transmit spacecraft commands to Goldstone and receive command verification data from Goldstone via the NASCOM 494CP. The OCC shall receive the real-time PCM telemetry data via the NASCOM 494CP.

C. NTTF

The OCC shall transmit spacecraft commands to the NTTF and receive command verification data from the NTTF via the NASCOM 494CP. The OCC shall receive the real-time PCM telemetry, the dump PCM telemetry and dump on-board computer data via direct hardline(s).

D. Backup Stations

The OCC shall transmit spacecraft commands to the backup stations and receive command verification data from the backup stations via the NASCOM 494CP. The OCC shall receive the real-time PCM telemetry data via the NASCOM 494CP.

The NTTF/OCC and NASCOM/OCC Interface Equipment shall be GFE. The NTTF/OCC interfaces are defined in the NTTF/OCC Interface Control Document (ICD-TBR).

3.1.3.2.3 Tracking and Data Relay Satellite System Subnet

The TDRSS subnet shall provide the communication facility for transferring EOS spacecraft command and telemetry data between NASCOM and the spacecrafts. The TDRSS subnet consists of two TDRS satellites and a TDRS Ground Terminal at White Sands, New Mexico.

The three modes of operation between the OCC and the TDRSS subnet are as follows:

A. Single-Access Mode

This mode utilizes the TDRS K_u and S-Band antenna and the EOS Satellite TDRS antenna for transfer of payload and TT&C data between the satellites.

The OCC shall transmit spacecraft commands to the TDRS Ground Terminal and receive command verification data from the TDRS Ground Terminal via the NASCOM 494CP (TBD). The OCC shall receive the real-time PCM telemetry data via the NASCOM 494CP (TBD) and the dump PCM telemetry and dump on-board computer data via the GSFC X-144 data transmission terminal (TBD).

B. Multi-Access Mode (Normal)

This mode utilizes the TDRS S-Band Array Antenna and the EOS Satellite TDRS antenna for transfer of TT&C data between the satellites. The OCC shall transfer real-time spacecraft commands (at reduced rates) to the TDRS Ground Terminal and receive command verification data from the TDRS Ground Terminal via the NASCOM 494CP (TBD). The OCC shall receive the real-time PCM telemetry data via the NASCOM 494CP (TBD).

C. Multi-Access Mode (Backup)

This mode utilizes the TDRS S-Band Array Antenna and the EOS omni-directional S-Band antenna for transfer of backup command data between satellites. The OCC shall transfer real-time backup commands (at greatly reduced rates) to the TDRS Ground Terminal and receive command verification data from the TDRS Ground Terminal via the NASCOM 494CP (TBD).

The TDRSS/OCC interfaces are defined in the TDRSS/OCC Interface Control Document (ICD-TBR).

3.1.3.2.4 Space Shuttle Interface

The OCC interface for supporting EOS Spacecraft-Space Shuttle activities shall be through the Space Shuttle OCC located at Johnson Space Center at Houston, Texas via NASCOM. The OCC shall transmit EOS spacecraft commands to the Space Shuttle

OCC, for approval, reformatting and re-transmission to the Space Shuttle and to the EOS spacecraft via hardware, and receive command verification data from the Space Shuttle OCC via the NASCOM 494CP (TBD). The OCC shall receive the EOS spacecraft real-time PCM telemetry data from the Space Shuttle OCC via the NASCOM 494CP (TBD) and the dump PCM telemetry and dump on-board computer data via the GSFC X-144 data transmission terminal (TBD).

The Space Shuttle OCC/OCC interfaces are defined in Space Shuttle OCC/OCC Interface Control Document (ICD-TBR).

3.1.3.3 Goddard Space Flight Center

The OCC interface with Goddard Space Flight Center shall include a facility interface and a timing data and reference signal interface.

3.1.3.3.1 Facility

The Goddard Space Flight Center shall provide the facilities and services for the OCC in Building 23. The OCC/GSFC facilities interface defining space allocation, power and grounding requirements, air conditioning, and equipment interfaces shall be defined in the GDHS/GSFC Facility Interface Control Document (ICD-TBR).

3.1.3.3.2 Timing Data and Reference Signals

The OCC shall acquire time codes in the GSFC 36-bit serial Binary Time Code (BTC) Format, and the GSFC 42-bit parallel Time of Year (TOY) Format from the GSFC Timing Standard Interface Unit. The OCC shall also acquire a 1 M Hz continuous clock signal from the GSFC Timing Standard Interface Unit. This Interface Unit shall be provided GFE and located in the OCC. The interface shall be documented in the OCC/GSFC Timing Data and Reference Signals Interface Control Document (ICD-TBR).

3.1.3.4 NASA Communications Facility

The OCC shall have provisions for interfacing with the NASA communications facility to provide voice and teletype communications with remote stations, NASCOM, NOCC and other support elements of the mission system. Voice and teletype equipment requirements are defined in the "GDHS Communications and Data Equipment and Installation Requirements Interface Control Document" (ICD-TBR).

3.1.3.5 Low Cost Readout Stations

The Operations Control Center shall provide to the local user, at time of activation of the Low Cost Readout Station, with predicted ground antenna contact profiles as a function of time in the form of a computer listing for the satellite orbits over the local user coverage area based on coordinates of the ground antenna and the nominal spacecraft orbit parameters.

The Operations Control Center shall provide, periodically, local coverage schedules to the local users for their area of interest on which the local users will establish those requests for transmission of image data from the satellites.

Confirmation of local user requests shall be provided by the Operations Control Center in the form of predicted spacecraft acquisition time and position, period of transmission over the requested area, and instrument data and mode to be transmitted.

The exchange of data shall be through a telephone line datafax link. The specific formats for the data information exchange shall be in accordance with OCC/LCRS Interface Control Document (ICD-XXXX).

3.1.3.6 Prime International Readout Stations

The Operations Control Center shall provide, periodically, local coverage schedules to the Prime International Readout Stations for their area of interest on which they will establish their requests for transmission of image data from the satellites.

Confirmation of Prime International Readout Stations requests shall be provided by the Operations Control Center in the form of predicted spacecraft acquisition time and position and period of transmission over the requested area.

The exchange of data shall be through a telephone line datafax link. The specific formats for the data information exchange shall be in accordance with OCC (Prime International Readout Stations Interface Control Document (ICD-XXXX).

3.2 CHARACTERISTICS

3.2.1 PERFORMANCE

This section describes the performance requirements for the OCC subsystems. The OCC shall consist of three hardware subsystems and five software subsystems:

1. Communications and Data Distribution Subsystem
2. Computing Services Subsystem
3. Status Control and Display Subsystem
4. Communications Processing Subsystem
5. On-Line Processing and Analysis Subsystem
6. Off-Line Processing and Analysis Subsystem
7. System Activity Plan and Command Compiler Subsystem
8. Master Information Control Subsystem

A simplified block diagram of the OCC system including interfaces is illustrated in Figure 3-1. The functional requirements allocated to each OCC subsystem are defined in the following sections.

3.2.1.1 Communications and Data Distribution Subsystem

The Communications and Data Distribution Subsystem shall provide the OCC external interface functions for transfer of telemetry, command and OCC data between the OCC and the remote sites, and internal interface functions for data and control signal transfer between the Computing Services Subsystem and the Status Control and Display Subsystem. The subsystem shall consist of the following:

1. Signal Conditioning and Switching Unit (SCASU)
2. Computer Interface Equipment Unit (CIEU)
3. Magnetic Tape Recording Units (MTU's)
4. Maintenance and Operation Console (M&O)

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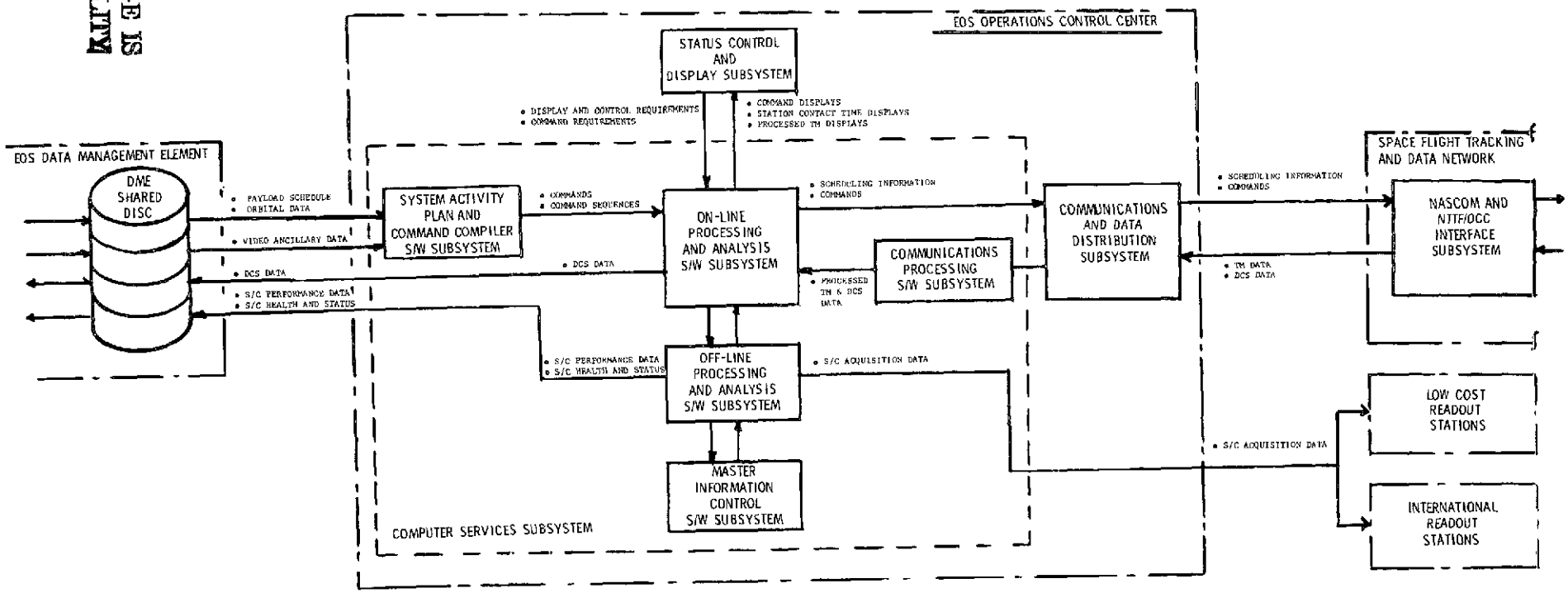

Figure 3-1. Operations Control Center Functional Block Diagram

3.2.1.1.1 Performance Requirements

This subsystem shall provide the equipment required within the OCC for input/output, signal conditioning and switching, ground time input and distribution, and magnetic tape recording of the telemetry, command and DCS data. This subsystem shall include the capability for generating analog PCM simulation data tapes in conjunction with OCC simulation software. The equipment in this subsystem shall be controlled and monitored by the Maintenance and Operation Console.

3.2.1.1.1.1 Signal Conditioning and Switching Unit (SCASU)

The Signal Conditioning and Switching Unit shall provide the capabilities required as follows:

- o Buffer/amplify input signals.
- o Provide routing of input signals by patch panel to any unit in the OCC at the appropriate level and impedance.
- o Provide switching of OCC signals, within 0.1 sec of receipt of a control signal, to establish a normal or backup OCC equipment configuration.
- o Provide switching of the method of routing OCC signals, within 0.1 sec of receipt of a control signal between the patch panel method (panel enabled mode) and the patch panel-independent method.
- o Cross-talk between SCASU signal lines shall be less than (TBD); i.e., the amplitude of a coupled signal in one output line, shall not exceed (TBD) of the nominal full scale amplitude of the normal signal on the coupled line.
- o PCM data in NRZ or Bi - Ø code formats, when routed through the applicable path of the SCASU shall not be degraded as measured by change in the Bit Error Rate by more than (TBD) db from the theoretical curve.
- o Provide a PCM Data Simulator for OCC test operations.
- o Provide test points for monitoring any signal routed within the SCASU at the front of the SCASU without further amplification prior to the test point.
- o Provide for selection of up to 24 signals by patch panel to be routed to the Maintenance and Operation Console.
- o Provide for selection by patch panel of the inputs and outputs to the Instrumentation Tape Recorders.
- o Provide for patching an identification number in each patch panel.

3.2.1.1.1.2 Computer Interface Equipment Unit (CIEU)

The Computer Interface Equipment Unit (CIEU) shall provide the capabilities required as follows:

A. General

All interface cables to/from the Direct Input/Output Distributor and interrupt facilities shall be connected in the CIEU to line driver/receiver modules of the OCC computers. Electrical, mechanical, functional, timing and other interface requirements shall be satisfied by the CIEU, or the CIEU in conjunction with other OCC equipment that generate/use Computing Services Subsystem signals via the CIEU. Power supplies in the CIEU shall be selected so that no single power supply failure shall cause failure in data transfer to/from both OCC computers.

Computing Services Subsystem data distribution to/from the OCC consoles via the CIEU shall be provided in at least two independent paths so that failure in one path does not disable the other path. An equal number of OCC consoles shall be on each path. The Operations Supervisor and Command Consoles shall be on different paths.

The CIEU shall not inhibit or otherwise interfere with Computing Services Subsystem equipment operations that share the use of the Computer/CIEU cables for control or data distribution.

B. Computer DIOD Interface

The CIEU shall provide the interface for data, address and function control signals between OCC Console panels requiring computer input/output and the DIOD facilities in both OCC computers. Both computer DIOD interfaces shall provide for a parallel 16 bit word transfer. Transfer of DIOD signals through the CIEU shall be done in less than 10 sec.

C. Computer Interrupt Interface

The CIEU shall provide for interfacing interrupts to the OCC computers from the OCC Consoles. Associated interrupt response lines from the OCC Computers shall be distributed to the consoles. Transfer of interrupt and interrupt response signals through the CIEU shall be done in less than 10 sec.

3.2.1.1.1.3 Magnetic Tape Recording Units

Performance requirements shall be allocated to the Analog Magnetic Tape Recorders (identical units required) as follows:

- The units shall satisfy the requirements of IRIG Document 106-69, Telemetry Standards, for intermediate band frequency response in the Direct Record Mode.
- The units shall have record/reproduce speeds from 3-3/4 to 120 ips.
- The units shall have provisions for remote control of forward/reverse, record/reproduce, fast forward/reverse, stop, and power on/off.
- PCM data in NRZ or Bi-Ø code formats, when recorded and played back on the units, shall not be degraded as measured by change in the Bit Error by more than (TBD) db from the theoretical curve.

3.2.1.1.1.4 Maintenance and Operation Console

The Maintenance and Operation Console shall provide the capabilities required as follows:

A. OCC Configuration Control Panel

- Switches shall be provided to control the selection of SCASU signal routing for normal or back-up OCC configurations.
- A switch shall be provided to enable or disable SCASU signal routing via the configuration patch panel.
- Switches shall be provided to control selection of SCASU signal routing for real time or playback OCC configuration.
- Switches shall be provided to control data transfer to the OCC strip chart recorders, and for start/stop function control of these recorders.
- Display of patch panel identification number, if patched, shall be provided.
- A control shall be provided for transmission of data to NASCOM.

B. Display Select Panel

A Display Select Panel shall be provided in the M&O Console to allow the operator to request desired software functions. This panel shall be the same as the Display Select Panel in the Status Control and Display (SC&D) subsystem.

C. Status Panels

Two Status Panels, one for each OCC computer, shall be provided in the M&O Console. These panels shall be the same as the Status Panels described in the SC&D Subsystem.

D. Keyboard/Alphanumeric CRT Display

A Keyboard and an alphanumeric CRT display as described in the SC&D Subsystem shall be provided in the M&O Console.

E. Time Display Panel

A Time Display Panel as described in the SC&D Subsystem shall be provided in the M&O Console.

F. Signal Monitoring

An oscilloscope shall be provided in the M&O Console for monitoring the quality of signals that the SCASU distributes within the OCC. The oscilloscope shall be capable of displaying four traces simultaneously. The oscilloscope bandwidth shall be at least 500 kHz.

Switch controls shall be provided for selecting any four of 24 signals routed to the M&O Console for display on the oscilloscope. Changing of patch cords shall not be required to select signals for display.

3.2.1.1.2 Interface Requirements

3.2.1.1.2.1 Source and Type of Input Data

A. GSFC Facilities

- o NASCOM/OCC Interface Equipment output: 303 Modem NRZ-M data, clock and control signals; 205 Modem NRZ data and clock signals; and X144 data terminal NRZ PCM data.
- o NTTF/OCC Interface Equipment outputs: PSK Demodulator 4 kbps and 80 kbps Bi - Ø-L format PCM signals.
- o GSFC Time Interface Unit outputs: GSFC 42-bit parallel time-of-year and GSFC 36-bit serial GMT time codes.

B. Computing Services Subsystem

- o Wide Band Data Set Coupler outputs: data and control signals.
- o PCM Bit Synchronizer outputs: reconstructed 4 kbps or 80 kbps NRZ-L PCM, 0° clock, and 90° clock.
- o Computer CPU's: Vehicle Time Data, Strip Chart Recorder Data, PCM Simulator Data, Console Display Panel Data, addresses, data transfer control signals, interrupt response signals, and AOS/LOS Display initialization data.

C. Status Control and Display Subsystem

- o Consoles: data and interrupts, AOS/LOS Display initialization data, and data transfer control signals.

3.2.1.1.2.2 Destination and Type of Output Data

A. GSFC Facilities

- o 303 Modem inputs: 50 kbps data and control signals

B. Computing Services Subsystem

- o Wide Band Data Set Coupler input: 50 kbps data, clock, and control signals.
- o PCM Bit Synchronizer inputs: 4 kbps NRZ-L or Bi-Ø-L, 80 kbps NRZ-L or Bi-Ø-L, or 50 kbps NRZ-L or Bi-Ø-L.

C. Status Control and Display Subsystem

- o Consoles: vehicle and GMT time data display panel data, addresses, data transfer control signals, interrupt response signals, AOS/LOS display initialization and running time data.
- o Strip Chart Recorders: analog and digital data, vehicle and GMT time data, start/stop control signal.

3.2.1.2 Computing Services Subsystem

The Computing Services Subsystem shall provide the communication, processing, and computational functions necessary for OCC operations and the internal interface functions with the Communication and Data Distribution Subsystem. The subsystem shall consist of the following:

1. Wide Band Data Set Coupler Units
2. PCM Front End Units
3. Computational Equipment

3.2.1.2.1 Performance Requirements

This subsystem shall provide the equipment required within the OCC to acquire and synchronize a serial PCM data signal in real-time or playback and transfer the data in parallel to the Input/Output Processors of the two OCC computers within this subsystem and provide the interface with the full-duplex Bell System 303 Data Sets.

3.2.1.2.1.1 Wide Band Data Set Coupler (WBDSC) Unit

Two Wide Band Data Set Coupler Units shall be provided. The WBDSC shall operate in a character mode with character lengths of up to 8 bits. The unit shall test character parity. Parity shall be program selectable as odd, even or none. Sync patterns shall be under program control and shall be program selectable from message to message.

The WBDSC unit shall:

- Terminate a single synchronous full-duplex line from a Bell System 303 Data Set with a line rate up to 50 Kbps.
- Provide full-duplex mode data transfers between the 303 Data Set and the OCC computers.
- Test for and recognize an 8 bit sync pattern specified by and loaded from the OCC computers.
- Upon sync pattern recognition, generate a computer I/O interrupt.
- Provide status function signals to the OCC computers to indicate parity rate and check-sum errors on data transfer between the computers and the WBDSC.

- o Provide signals to the OCC computers to indicate status of AGC Lock, Data Set Ready, Clear to Send, and Ring Indicator functions in the 303 Data Set.

3.2.1.2.1.2 PCM Front-End Unit

Two PCM front-end units shall be provided. The PCM Front-End Units shall consist of a bit synchronizer, frame synchronizer and subframe synchronizer, with associated control and interface logic that may be under local (manual) or remote (Computing Services Subsystem) control.

A. Bit Synchronizer

The bit synchronizers shall:

- o Extract serial PCM data from both filtered and unfiltered noise-contaminated inputs and reconstruct the signal within 1 db of the theoretical bit error probability curves for all standard IRIG 106-69 codes in the range from 10 bps to 600 Kbps.
- o Reconstruct the data and convert the reconstructed data to standard NRZ and Bi0 output codes.
- o Provide local or remote control of all operating parameters.
- o Provide six selectable inputs.
- o Resolve phase ambiguity for Bi0 codes.
- o Provide signal conditioning for RZ, NRZ-L, NRZ-M, NRZ-S, Bi0-L, Bi0-M, and Bi0-S codes.
- o Accept inputs signals with DC offsets up to 100% of the input peak-to-peak amplitud
- o Accept, without adjustment, input signals between the range of 0.5 to 60 volts peak-to-peak.
- o Provide three loop bandwidths of 0.1%, 0.3% and 3.0% with acquisition bandwidths of 1%, 5%, and 10% respectively.
- o Acquire and maintain bit synchronization:
  - within 100 bit periods for incoming signals within $\pm$ 2% of the selected bit rate and S/N $\geq$ 15 dB.
  - within 500 bit periods for incoming signals within 10% of the selected bit rate and S/N $\geq$ 15 dB.
  - within 1000 bit periods for incoming signals within $\pm$ 1% of the selected bit rate and S/N $\geq$ 8 dB.
  - for S/N $\geq$ 15 db and incombing signal jittering with $\Delta f \leq \pm$ 2.0% of bit rate at any modulating frequency.

- o Maintain bit synchronization for NRZ codes at stable input rates under the following conditions:
  - with noise only, the sync threshold is -3.0 dB.
  - with noise only, the unit shall maintain sync with no bit slippage (less than one slip per million bits) for $S/N \geq 3.0$ dB.
- o Provide output data indicating the selected control parameters.
- o Provide for reversing the selected control parameter.
- o Provide an input level meter to indicate sufficient input signal level for proper operation.
- o Provide indicators for loss of signal, excessive d.c. offset and synchronization.

B. Frame Synchronizer

The Frame Synchronizers shall:

- o Accept NRZ-1 serial PCM signal with 0° and 90° clocks at the bit rate.
- o Accept input rates up to 2.5 Mbps.
- o Accept data syllable lengths from 4 to 16 bits.
- o Accept frame lengths from 2 to 4096 syllables.
- o Provide parallel output, LSB or MSB justified.
- o Accept frame synchronization words up to 33 bits long.
- o Accept frame sync patterns in any combination of ones and zeros up to 33 bits.
- o Accept frame sync patterns alternating on successive frames with its complement or the pattern complement appearing at the subframe rate.
- o Provide synchronization strategy of:
  - 0 to 15 bit errors in search mode.
  - 0 to 15 bit errors allowed and 0 to 15 consecutive acceptable patterns in the check mode.
  - 0 to 15 bit errors allowed and 0 to 15 consecutive incorrect patterns in the lock mode.
- o Provide a 12 bit binary address tag to identify syllables.
- o Provide an output parity bit.
- o Provide a 4 bit count of sync pattern errors.
- o Provide remote verification of program loading.
- o Provide a display of synchronization status.
- o Provide a control to return sync logic to the search mode.

C. Subframe Synchronizer

The subframe synchronizers shall:

- o Accept serial NRZ-L data from the frame synchronizer at rates up to 2.5 Mbps.
- o Accept subframe lengths up to 5.2 frames.
- o Provide ID synchronization with up to 9 bits, ascending or descending count, MSB or LSB first.
- o Provide synchronization strategy as follows:
  - Search mode at first count detected.
  - Check mode at 0 to 15 consecutive acceptable patterns.
  - Lock mode at 0 to 15 consecutive acceptable patterns.
- o Provide a 4 bit count of bit errors detected in the sync patterns.
- o Provide sync status output signals.

3.2.1.2.1.3 Computational Equipment

Two OCC computer systems shall be provided. Each computer system shall consist of the central processor, standard computer peripheral equipment and operating system software.

A. Central Processor

Each OCC Central Processor shall consist of:

- o 6 μsec LAS (load, add, store) time CPU
- o 128K words of on-line memory
- o Input/Output processors (IOP's) as required to handle computer peripherals
- o 2 real-time clocks
- o Power fail safe
- o Memory protection
- o Additional register block
- o Floating point arithmetic
- o Priority interrupts
- o Direct Input/Output Distributor (DIOD) feature and IOP (shared) interfaces to the CIEU of Communications and Data Distribution Subsystem.

B. Standard Computer Peripheral Equipment

The peripheral equipment shall consist of:

- o Card punch
- o Card reader
- o Four interface units for the alphanumeric CRT Display/Keyboard sets in the Status Control & Display Subsystem.
- o High speed line printer
- o 5.7 mb RAD disc
- o Four 9-track tape drives
- o 49 mb disc
- o Two communications controllers
- o Peripheral switching equipment to share the following equipment with the other OCC computer:
  - Line printer
  - Four alphanumeric CRT Display/Keyboard Interface Units
  - A 24 mb disc shared with the DME

C. Operating System Software

The Operating System Software shall provide the capability to create and operate the OCC applications programs. The operating system shall include the following:

a. The executive element

b. The language processors

c. The utility services

The executive element shall enable the execution of the OCC applications programs in three operating modes:

a. Real-time, in support of spacecraft data acquisition

b. Batch, for in-depth PCM processing off-line

c. Interactive operation, for machine-aided system scheduling, command compilation and data evaluation.

The language processors shall be used during the program development phase to create and modify the applications software. These processors shall include:

a. Fortran

b. Assembly language

The Utility services shall consist of software packages designed to provide common services to applications and system software. These utility services shall include:

a. Statistical analysis

b. Peripheral device handling

c. Program debug

d. Data base maintenance

e. Sort/merge

3.2.1.2.2 Interface Requirements

3.2.1.2.2.1 Source and Type of Input Data

The OCC computers shall receive data from the Wide Band Data Set Couplers at 50 kbps in 1200-bit blocks as follows:

- Real-time PCM Data
- Playback PCM data
- Command Acknowledge Messages
- Other data link housekeeping messages

The OCC computers shall receive data from the PCM Units for control and processing:

- Four 16-bit words from the bit synchronizer shall be received to verify proper program loading.
- Eleven 16-bit words from the frame synchronizer shall be received to verify proper program loading.

- Seven 16-bit words from the subframe synchronizer shall be received to verify proper program loading.

- An 8-bit status byte shall be received to indicate frame sync, bit sync, subframe sync, bit sync control, frame sync control, subframe sync control, input level, and bit slippage status.

- 16-bit data words shall be received from the frame synchronizer for data processing.

- Signals from the Command Panels and Data Select Panels of the SC&D S/S and C&DD S/S shall be received via the CIEU for processing.

- Timing signals consisting of ten 8-bit binary words representing days, hours, minutes, seconds, and milliseconds shall be received from the GST translators of the CIEU and sent to the OCC computers for processing.

- Signals from eight switches on the Configuration Panel of the M&O Console indicating the source of PCM data shall be received via the CIEU by the OCC computers for processing.

- Signals from two switches on the Configuration Panel of the M&O Console indicating real or playback PCM data shall be received via the CIEU by the OCC computer for processing.

- Signals from four switches on the Configuration Panel of the M&O Console indicating the command site selected shall be received via the CIEU by the OCC computers for processing

Status Control and Display Subsystem (SC&D)

- Control signals from the keyboards shall be received and processed for control and communications via the alphanumeric CRT displays.

3.2.1.2.2.2 Destination and Type of Output Data

The OCC computers shall transfer data to the WBDSC units at 50 kbps in 1200-bit blocks as follows:

1. Command messages

2. Data link housekeeping messages

The OCC computers shall transfer data to the PCM Units for control as follows:

- Four 16-bit words shall be generated and transferred to the bit synchronizer for synchronizer program.

- Eleven 16-bit words shall be generated and transferred to the frame synchronizer for synchronizer program.

- Seven 16-bit words shall be generated and transferred to the subframe synchronizer for synchronizer program.

- Two words representing 3 digits of minutes and 2 digits of seconds for AOS time and 2 digits of minutes and 2 digits of seconds for LOS time register loading shall be generated and transferred to the timing equipment in the CIEU by the OCC computers.

- Eight status signals representing spacecraft status shall be generated by the OCC computers and transferred via the CIEU to the Spacecraft Status Panels on the consoles for display.

- Signals representing acknowledgement of receipt of Command Panel switch settings shall be generated and transferred by the OCC computers via the CIEU to the Command Panels for display.

- Signals to drive the analog and discrete channels of the Analog/Event and Event Recorders shall be generated by the OCC computers and transferred via the CIEU to the recorders.

- Signals generated by either OCC computer to provide data to the PCM signal simulator in the CIEU.

- Ten 8-bit BCD words representing vehicle time in days, hours, minutes, and seconds shall be generated by the OCC computers and displayed on the stripchart recorders and consoles via Vehicle Time Translator equipment in the CIEU.

- Three 8-bit words of status from the OCC computers shall be generated for transfer via the CIEU to status panels on the M&O console.

- Four signals shall be generated by the OCC computers and transferred via the CIEU to the Configuration Panel on the M&O console to indicate acknowledgement of receipt of PCM data source selection signals generated by the panel.

- One signal shall be generated by each of the computers indicating that the computer is powered and running.

- Four signals shall be generated by each of the computers and transferred via the CIEU to the Configuration Panel on the M&O Console to indicate acknowledgement of receipt by the computer of command site selection signals generated by the panel.

Status Control and Display Subsystem

- Signals shall be generated for the generation of symbols on the alphanumeric CRT displays via the four interface units controlling the display generators.

3.2.1.3 Status Control and Display Subsystem

The Status Control and Display Subsystem (SC&D) shall provide OCC, mission, and spacecraft system status data to operations personnel. The SC&D S/S shall consist of the following equipment:

- Operations Supervisor (OS) Console - 1 each
- Command Console - 2 each
- Spacecraft Evaluation Console - 2 each
- Analog/Event Recorder - 4 each
- Event Recorder - 1 each
- Trend Analysis Plotter and Tape Drive - 1 each

3.2.1.3.1 Performance Requirements

3.2.1.3.1.1 Consoles

All consoles shall have the same basic configuration. Each console shall be equipped with an alphanumeric CRT display, an associated input keyboard, function keys that permit access to the OCC computer program subsystems, a spacecraft time display, GMT display, Pass-Time display, Communications Panel, and a Spacecraft Status display driven by the computer. In addition to the basic configuration, the Command and OS Consoles shall contain a Command Panel for the initiation of commands. Provisions shall be made for selecting only one Command Panel or the other to be active and interface with the Computing Services Subsystem at any one time.

3.2.1.3.1.1.1 Controls

A. Keyboard

Each console shall contain one keyboard assembly to enable the console operator to control the alphanumeric CRT display and communication with the OCC Software and Computing Services Subsystems. The keyboard shall contain keys A through Z, 0 through 9, 28 special symbols, punctuation marks and 14 special function keys for control.

B. Command Panel

Command panels shall be provided in the Operations Supervisor and Command Consoles to allow set up and initiation of commands to the Computing Services Subsystem.

1. Dedicated Command Switches. Twelve pushbutton switches dedicated to specific commands shall be provided on each panel.

2. Mode Switches. Each panel shall contain the following command panel mode selection switches:

   - o Operate
   - o Edit
   - o Test
   - o Panel Disable

3. Command (COMDEC) Decoder Control Switches. Each panel shall contain the following COMDEC selection switches:

   COMDEC A

   COMDEC B

4. Master Clear Switch. Each panel shall contain a Master Clear switch.

5. Critical Command Switches. Each panel shall contain the following critical command pushbutton switches:

   - Critical Command Enable
   - Transmit

6. Command Panel Select Switch. Controls shall be provided on the panel in the Operations Supervisor Console to select either the Command Console Command Panel or the Operations Supervisor Console Command Panel for commanding. Only the selected panel shall be enabled to initiate commands.

7. Command Keyboard. A numberic keyboard shall be provided in each panel to allow transmission of 3 digit (000 through 999) numerical commands to the Computing Services Subsystem. An ENTER pushbutton shall be provided to enable the transfer of commands.

8. Emergency OFF Switch. An Emergency OFF pushbutton switch shall be provided to disable the command panel.

C. Display Select Panel

A Display Select Panel containing eight pushbutton switches shall be provided in each console to allow the console operator to indicate to the Computing Services Subsystem the data desired on the alphanumeric display.

D. Manual Pass-Time Set Panel

A Manual Pass-Time Set Panel shall be provided on the OS console to provide the capability to override the computer initialization of the AOS/LOS time generator in the Communications and Data Distribution Subsystem. Controls and circuitry for setting the time shall be as follows:

AOS	LOS
Minutes Seconds	Minutes Seconds
sign (±) 3 digits 2 digits	sign (±) 2 digits 2 digits

ENTER pushbuttons shall be provided for AOS and LOS to enter the selected times. Controls shall also be provided to select Auto (computer) or Manual Mode of Initialization and to Start or Stop the time generator.

3.2.1.3.1.1.2 Displays

A. Alphanumeric CRT Displays

Alphanumeric CRT displays shall be provided in each console with capability of displaying the same symbols as required for the keyboard.

The alphanumeric CRT displays shall have controls to adjust the height, width, horizontal linearity, contrast, focus, and brightness of the CRT display. The alphanumeric CRT display shall have the capability to display 20 lines of 80 characters per line. The CRT shall have a display area with a diagonal measurement of 14 inches.

B. Time Display

A display of Greenwich Mean Time, Vehicle Time, AOS Time, and LOS time shall be provided for each console. The GMT and Vehicle Time displays shall both include 3 digits of day of year, 2 digits of hours, 2 digits of minutes, and 2 digits of seconds. Time of Acquisition of Signal (AOS) shall be displayed as 3 digits of minutes and 2 digits of seconds with + and - symbols. Loss of Signal (LOS) time shall be displayed as 2 digits of minutes and 2 digits of seconds with + and - symbols. Indicators shall also be provided to indicate that no vehicle time is being sent from the computer. Lamp test shall be provided.

C. Status

A status decoder and display shall be provided to display eight event indicators to display the status of spacecraft subsystem functions. Lamp test shall be provided.

D. Configuration Status

An OCC Configuration Status Panel in the OS Console shall be provided to display the configuration of OCC equipment. This panel shall be the same as the Configuration Panel of the M&O Console except that only indicators shall be provided.

F. Command Panel Indicators

The following displays shall be provided on the Command Panels:

- Three digits (000 through 999) indicating the numerical command selected.
- Twelve dedicated command indicators built into the command pushbuttons.
- Four mode indicators built into the mode pushbuttons.
- Two COMDEC indicators built into the COMDEC pushbuttons.
- A Command Master Clear indicator built into the Command Master Clear pushbuttons.
- A TRANSMIT indicator, built into the TRANSMIT pushbutton.
- CRITICAL COMMAND, ILLEGAL ENTRY and TRANSMIT READY indicators driven via the Computing Services S/S.
- NORMAL and BACK-UP indicators driven from the M&O Console.
- OSC and CC SELECT indicator built into the OSC pushbutton and an indicator only on the CC indicating Operations Supervisor Console or Command Console is active for commanding.
- Lamp test shall be provided for all panel indicators.

3.2.1.3.1.2 Analog/Event Recorder

Each Analog/Event Recorder shall provide a hard copy display of eight channels of analog data, two time codes and seven discrete signals.

- Each analog channel shall have frequency response with 0 dB loss from dc to 55 at full scale P-P amplitude. Static and dynamic linearity shall be 0.5% full scale. Rise time shall be 4 msec at 50% deflection with 4% maximum overshoot.

- o Chart speeds shall be provided from 0.5 mm/sec to 200 mm/sec.

- o The time code channels shall be for Ground Station Time and Vehicle Time using pulse widths coded to indicate the time. There shall be four codes provided for each time, automatically selected as a function of recorder speed to allow maximum time resolution for the speed selected.

- o The time code channels shall have a response time sufficient for a 50 pps serial code.

- o The 7 discrete channels shall have response times sufficient for a 5 pps signal.

- o Each recorder shall be on wheels for easy movement from console to console as required to meet operational requirements.

3.2.1.3.1.3 Event Recorders

The Event Recorder shall provide a hard copy display of 30 event channels, Ground Station Time and Vehicle Time.

- o Chart speeds from 0.05 to 200 mm/sec shall be provided.

- o Ground Station Time and Vehicle Time shall use coded pulse widths to indicate time. Four codes shall be provided for each time, automatically switched as a function of chart speed to allow maximum time resolution for the speed selected.

- o The 30 event channels shall have a response time sufficient for a 5 pps signal.

- o The two time channels shall have a response time sufficient for a 50 pps signal.

3.2.1.3.1.4 Trend Analysis Plotter and Tape Drive

An X-Y plotter shall provide the following plotting capabilities on a vertical 45x60"surface. The plotter shall be capable of accepting data and control inputs from either magnetic tape or paper tape. Manual controls shall also be provided for selection of X-Y origin, scale factors, and plotter mode. X-Y origin shall be adjustable over a maximum range of 100 to 1000 counts per inch. Forty-eight symbols shall be provided, including:

- o The alphabet (capital letters)

- o The numbers from 0-9

- o Special charactres (+-, / .etc.)

- o At least six characters suitable for symbol plotting

Manual controls shall be provided from the front panel.

In each of the following modes, the plotter shall perform the function described. Each mode shall be selectable by input mode control character. A "plot" character shall indicate that inputs received are to be executed. A "standby" character shall place the plotter in a non-operating standby mode.

1. Pen Plot Mode. Inputs - X, Y. Move to the specified location and plot a point.

2. Printer Plot Mode. Inputs - X, Y, symbol, symbol orientation (vertical of horizontal). Move to the specified location and plot a point with the specified symbol. The symbol shall be horizontal (base of character down) of vertical (base of character to right), as specified. The orientation, once stated, shall remain the same until changed by a new selection.

3. Line Plot Mode. Inputs - X, Y, Pen (Latch or Unlatch), Line (Short or Long). Move from the current location to the specified location with the pen up (latched) or down (unlatched) as specified. The plotter shall meet the following requirements in the applicable mode:

o Point Plot speed with 48 char., printer, 1/8" spacing		200/min
o Random symbol select with 1/8" spacing		100/min
o Free run line plot with 1/8" spacing		1500/min
o Straight, line interpolation		.025
o Line plot end overshoot		.025
o Accuracy	X = $\pm$	.060
	Y = $\pm$	.050
o Repeatability	$\pm$	.020

Each plotter configuration shall incomporate a 9-track Potter model tape drive unit, and shall be modified to accept the 9-track inputs, or by plug change, permit return to the original configuration for calibration and checkout.

3.2.1.3.2 Interface Requirements for the Status Control and Display Subsystem

3.2.1.3.2.1 Source and Type of Input Data

A. Communications and Data Distribution Subsystem

- o M&O Console output: signals to drive the Configuration Panel displays.
- o CIEU output: AOS and LOS time displays initiated from the Computing Services Subsystem via the Computer Interface Equipment Unit (CIEU) and updated from the CIEU.
- o CIEU output: GMT displays; Vehicle Time displays; Command Panel Display Select and Spacecraft Status panels.

- Analog/time signal, and discrete input signals to the Analog/Event and Event Recorders.

B. Computing Services Subsystem

Signals to drive the Alphanumeric CRT Displays shall be received from the Computing Services Subsystem.

3.2.1.3.2.2 Destination and Type of Output Data

A. Communications and Data Distribution Subsystem

- CIEU inputs: signals from the Command Panels and Display Select Panels and signals from the Pass-Time Set Panel.

B. Computing Services Subsystem

- Control and data signals from the keyboards transferred to the Computing Services Subsystem for control and communication via the alphanumeric CRT display controllers.

3.2.1.4 Communications Processing Subsystem (DECOM)

3.2.1.4.1 Performance Requirements

The Communications Processing Subsystem (DECOM) shall verify synchronization of and decommutate all spacecraft PCM telemetry and DCS data input to the OCC, and distribute this data to stripchart recorders, displays, and the OCC computers. Either real-time or playback data shall be accepted. DECOM shall provide for the following:

- Three tables of synchronization parameters to be used with high, medium and low signal-to-noise ratio data.
- Receive and check synchronization of the TLM data received from the Wide Band Data Set Coupler (WBDSC) or the PCM Front End.
- Control of the PCM Front End Unit used to synchronize TLM data received in serial bit stream form.
- Output to a maximum of 96 analog strip chart recorder channels.
- Output to maximum of 84 digital strip chart recorder channels.
- Time smoothing and major frame annotation for playback data.

- o Output of raw PCM data (along with sync and data quality information) to a magnetic tape unit.
- o Transfer of data to the OCC computers on a major frame basis.
- o Output command information to a line printer.
- o Output of vehicle time to a time code translator.
- o Interface for commanding and command verification data transfers via the WBDSC.
- o Output to the M&O Console status lights to indicate quality and status of data.
- o Validation of incoming DCS data blocks and output of the confirmed blocks to a tape interface.
- o Variable stripchart recorder display of telemetry data by changing tables on-line in real- time.

3.2.1.5 On-Line Processing and Analysis Subsystem (ONPAS)

3.2.1.5.1 Performance Requirements

The On-Line Processing and Analysis Subsystem (ONPAS) shall accept and process decommutated real-time data and perform frame-by-frame processing functions. This subsystem shall also construct, transmit, and verify commands and command sequences, and receive and display reports concerning real-time PCM data.

ONPAS shall consist of the following:

1. System Request Executive (SRE)
2. PCM Acquisition Supervisor (PAS)
3. Real-Time Telemetry Processing Package (RTP)
4. Subsystem Display (SUBD)
5. Time Slot Display (TSD)
6. Memory, Matrix, and Emergency Mode Verify (MMEV)
7. Report Generator Supervisor (RGS)
8. Report Generator Packages (RGP)
9. Command Management Program (CMP)

3.2.1.5.1.1 System Request Executive (SRE)

This program shall accept parameters input from the operations consoles to alter the current mode of operation. It shall communicate with PCM Acquisition Supervisor (PAS), Report Generator Supervisor (RGS), DECOM and Command Management (CMP) to synchronize program execution. SRE shall meet the following requirements:

- o Provide signals for external control of initiation, modification and conclusion of processing by PAS.
- o Accept PCM data from DECOM.
- o Supply interrupt signals to PAS indicating the availability of a major frame of PCM data for processing.
- o Provide an interface with RGS and CMP via interrupts or event requests and signals.
- o Accept real time PCM telemetry.
- o Provide the means to vary synchronization tables for PCM decommutation hardware.
- o Provide capability to vary decommutation tables.
- o Establish and alter stripchart display formats.
- o Conclude processing via input from M&O Console.

3.2.1.5.1.2 PCM Acquisition Supervisor (PAS)

PAS shall provide the logical control of normal PCM data processing. Acting on interrupts from SRE, PAS shall supervise the processing of real-time PCM data. The program will have the following capabilities:

- o Accept and operate on external requests transferred by the Systems Request Executive.
- o Automatically detect all Matrix, Memory, and/or 1024 mode data and call in the Matrix Memory Emergency Mode Verify Report (MMEV)
- o Call in and control Real-Time Telemetry Processing.
- o Call in the control Time Slot Display.
- o Call in and control Subsystem Report.
- o Accept current GMT and transfer it to the operating on-line program

3.2.1.5.3 Real-Time Telemetry Processing Package (RTP)

RFP shall provide the following processing operations in real-time for each frame of normal telemetry data:

- Reformatting of raw PCM matrix data into a predefined sequence of telemetry functions with all multiple sampled telemetry functions in forward order.
- Range-checks of all analog functions selected.
- Determination of spacecraft event status with the number of events limited to 200. Maximum of six functions used to determine event status.
- Mode dependent limit checking on all analog functions selected by the Master Information File (MIF).
- Verification of real-time command execution.
- Conversion of selected analog functions from PCM counts into TMV or engineering units using one of four predefined calibration types.
- Determination of alarm conditions selected by Master Information Table (MIT) and lighting of two or more dedicated status lights on the consoles.
- Generation of real-time subsystem reports (sets) upon request.
- Computation of any alarm/event or all events from a specific subsystem may be inhibited.
- Output to printer and/or CRT.

3.2.1.5.1.4 Subsystem Display (SUBD)

This program shall accept spacecraft telemetry data in raw telemetry matrix form, order the data by function number, convert to telemetry voltage levels (or octal counts where applicable,) and generate data displays to monitor functions/subsystem performance. Subsystem Display shall provide for the following:

- Selected data formatted by the subsystem
- Identification of functions by name
- Identification of Digital B on-off status
- Display of every frame of TLM data in non-real time operation (OFPAS mode).
- Display of alternate frames of data in real-time when the printout exceeds four pages.

3.2.1.5.1.5 Time Slot Display (TSD)

TSD shall accept spacecraft telemetry data in matrix form either in real-time or playback and print the data in a matrix format. TSD shall provide the following:

- o Print the complete matrix or specified rows or columns every frame while processing in real-time.
- o Convert analog TLM data into telmetry volts (0.000 to 6.37).
- o Convert digital B TLM into an octal display (000 to 1777).

3.2.1.5.1.6 Memory, Matrix, and Emergency Mode Verification (MMEV)

MMEV shall accept telemetry in the memory verify mode, matrix verify mode, emergency mode, and 1024 counter mode and shall produce reports for verification. In the reports the following are identified:

- o Discrepancies between memory and a predefined set of memory data.
- o Discrepancies between matrix gate numbers and expected gate numbers.
- o Emergency mode data.

3.2.1.5.1.7 Report Generator Supervisor (RGS)

RGS shall supervise the presentation of displays by loading required Report Generator Packages (RGP's) and linking these packages to the display devices. RGS shall meet the following requirements:

- o Operate on-line upon activation by SRE or operate off-line.
- o Maintain real-time display headers from current PCM frame input.
- o Call RGP's to produce reports.
- o Interpret control commands from OCC consoles.
- o Generate COMMON display tables to control RGP's.
- o Perform these services:
  - new display request
  - page freeze/unfreeze request
  - next page request
  - produce hard copy output.

3.2.1.5.1.8 Report Generator Package (RGP)

One RGP shall be required for each report to be generated/displayed. Each RGP shall contain necessary columnar headings and tabular information, formatting and conversion statements used to display report data, and logic to perform page changing and display updating. RGP's shall operate on either line printer or CRT display devices. They shall execute these requests from RGS:

- o new display
- o update display
- o page change
- o hard copy

The following reports shall require an RGP:

Display Catalog
Command Sequence Catalog
Command Sequence Display
Compiled Command List
Real Time Command Display
Detailed Command History
Stored Command Verify Report
Ground Stored Command Display
Spacecraft Status Change
Full Status Report
Status Check
Check Table Contents
Alarm Condition Report
Gap
Limit Summary
Selected Real Time Data Sets (Controls, Power, etc.)
Data Listing
Station Contact Data
Various Procedures Lists

3.2.1.5.1.9 Command Management Program (CMP)

The Command Management Program (CMP) shall provide for the creation, storage, retrieval and transmission of all prestored and real-time commands and sequences. CMP shall operate in a real-time mode under the control of requests from the Command Console operator.

This program shall supply the following functions:

- o Retrieval upon request of all specified command sequences for transmission
- o Examination of retrieved sequences for "critical" commands.
- o Generation of alarm display for "critical" commands.
- o Computation of delta times for stored program commands in stored sequence
- o Formatting of encoded commands for transmission.
- o Transfer of unencoded commands to PCM processing system programs.
- o Transmission in real-time of stored sequences, real-time commands, commands.
- o Transmission of single commands or sequences at prespecified times.
- o Verification of stored command loading.
- o Transmission of a pre-defined sequence of sequences.
- o Edit capability of stored sequences.
- o Recognition of illegal commands.
- o Acceptance of parameters and function key inputs from SRE.
- o Test mode operations capability.

Transmission to remote sites shall take the form of command messages consisting of one or more complete 1200-bit communication blocks.

Remote sites may also receive control messages that contain instructions for command message processing. Two types of control message may be sent, as follows:

1. Flush Message - Instructs the remote site to cancel an incomplete message.
2. Abort Message - Instructs the remote site to terminate any command message processing that is in progress.

Both types of messages contain only one block. The flush message block consists of the standard NASCOM header, test data and information, and an error control code field. The abort message block contains each of the above segments, and also includes a Spacecraft Command Encoder (SCE) header required for the SCE system (following the project header).

Each OCC 1200-bit NASCOM block shall consist of:

- o NASCOM header bits
- o SCE header bits
- o Command data to be uplinked
- o SCE trailer bits
- o Filler bits
- o Polynomial code bits

Each command message shall begin with a 50-bit dummy command that is used to establish positive contact with the spacecrafts before any legitimate command data is transmitted.

The dummy command shall be followed immediately by the spacecraft command(s) to be executed.

The number of blocks that make up the block size of each message shall be determined by the total number of commands to be included. If 1-15 commands are to be transmitted (following the dummy command), a single-block message shall be sent. If 16 or more commands are to be transmitted, a multiple-block message shall be necessary.

The maximum content of a normal command message shall be 70 commands, and shall require five communications blocks. The message size (number of component blocks) shall be indicated as an Introduction Block message.

The Command Management Program software shall be accessed through the Command Console and the Operations Supervisor Console Command Panel. In addition, sequences of commands generated by the Command Compiler Subsystem and stored on the disc will be available. Command data shall be transmitted by hard line via the Wide Band Data Set Coupler Unit or by punched paper tape to GSFC for mailing to the backup stations.

3.2.1.6 Off-Line Processing and Analysis Subsystem (OFPAS)

3.2.1.6.1 Performance Requirements

The Off-Line Processing and Analysis Subsystem shall contain the control, analysis, and ancillary software necessary to prepare and display spacecraft data in a meaningful format. In-depth analyses shall be performed, and trend information shall be provided.

OFPAS shall consist of the following:

1. Off-Line Supervisor (OLS)
2. Playback Telemetry Processing Package (PTP)
3. Power Analysis (PA)
4. Statistics, Controls, Evaluation, Stack and Thermal (SCEST)
5. Data Listing Program (DLP)
6. General Averages Program (GAP)
7. Plot Tape Generator (PTG)
8. Command Verification (CMV).

3.2.1.6.1.1 Off-Line Supervisor (OLS)

The prime requirement for OLS shall be to store real-time or playback PCM data from a Raw Data Tape (RDT) on the disc. OLS shall then control the sequence of activities to be performed on this data. The program shall provide the following:

- Initiation and control of all off-line processing.
- Interpretation of control cards to determine which application program shall be called in.

- o Storage of data on the disc.

- o Access to data on the disc to supply application programs with a major frame of data.

- o Command data from the disc to the application programs.

3.2.1.6.1.2 Playback Telemetry Processing Package (PTP)

PTP shall perform the following processing operations:

- o Reformatting of the raw PCM matrix data to provide the following:

  - - Re-ordering the PCM matrix into a predefined sequence of telemetry functions.

  - Storing of all multiple samples telemetry in forward time sequence.

  - Unpacking of Digital B samples.

- o Range checking for up to four ranges for analog functions selected by the Master Information File (MIF).

- o Determining event status once each frame. Each event may have up to six states. Maximum number of events is 200.

- o Mode-dependent limit checking on functions selected by MIF. Maximum number of modes is 6.

- o Producing the Limit Summary Report which contains minimum and maximum values, total number of samples, number of samples out of limits high and low.

- o Calibrating (in engineering units) using curve functions defined by MIF. Override permits all analog functions to be calibrated in TMV units.

- o Verifying commands.

- o Variable analog data and event smoothing.

- o Calculating data span in spacecraft time and frame number.

- o Determining spacecraft night to spacecraft day transition.

- o Calculating percentage of bad data and missing data.

- o Producing the Alarm Report to indicate an emergency condition within the spacecrafts.

- o Generating the enhanced matrix.

- o Computing a predefined set of pseudo functions to be stored in the enhanced matrix.

3.2.1.6.1.3 Power Analysis (PA)

Power Analysis shall generate the data necessary for evaluation and operational analysis of the Power Subsystem performance. All calculations shall be mode-dependent upon spacecraft day or night determination. Power Analysis shall not accept data until a valid spacecraft day/night is established, nor shall it accept out-of-sync or out-of-range data. This program shall provide for the following:

- Generation of an orbital or Day/Night-Night/Day segment Power Summary Analysis.
- Generation of a detailed power summary per major frame.
- Determination of array currents, array amp minutes, aux load amp minutes, shunt load amp minutes, unregulated bus voltage, regulated bus currents, regulated bus amp minutes, and Power Subsystem losses.
- Battery performance evaluation and total system computations including charge/discharge ratios for consecutive frames of data over one power management orbit.
- Prediction of solar array current and comparison of this prediction with the normalized current over a predetermined range of paddle temperatures.
- Accumulation of telemetry values for each function until mode change occurs.
- Maintenance of a missing values count.
- Time gap checking between major frames.
- Extrapolation/interpolation for cross-orbit data.
- Disc storage of cross-orbit power information.
- Disc storage of orbital data for next power management.
- Accumulation of auxiliary and shunt load values when in an ON condition.

3.2.1.6.1.4 Statistics, Controls, Evaluation, Stack & Thermal (SCEST)

SCEST shall read the calibrated data records and use this data to perform general statistics for all telemetry data. In addition, SCEST shall generate special reports for the Thermal & Controls Subsystem. The program shall provide the following:

- Mean, maximum and minimum values for each analog function in a specified mode defined by MIF.
- Bellows temperature, shutter position, bay temperatures, component temperatures, battery temperatures, and other section temperatures in the form of a thermal printout.

- o Determination of duty cycles of up to six different events, and average values for up to nine Power Subsystem functions.
- o Outputs consisting of statistical summary data, temperature/pressure ratios, thermal, power, and controls data.
    - Statistical summary data may be printed on a single subsystem per page basis.
    - Statistical summary data may be deleted for one or more subsystems.

3.2.1.6.1.5 Data Listing Program (DLP)

DLP shall use either the enhanced data file or raw data to list, as a function of time, any spacecraft telemetry function. This program shall provide the following capabilities:

- o One to ten functions may be specified for processing.
- o One to four modes per function may be selected.
- o Maximum of two time or frame spans may be selected.
- o Data may be stored on disc for plotting.
- o DLP shall be interactive and respond to inputs from the CRT keyboards in the OCC consoles.

Printouts shall occur as a function changes value. Both the new value and the major frame increment since last printout shall be displayed. DLP printouts shall include:

- function numbers
- function names
- function modes
- first sample of all selected telemetry functions

3.2.1.6.1.6 General Averaging Program (GAP)

GAP shall use either the enhanced data file or the raw PCM data to present statistics on selected analog functions. The program shall provide for the following:

- o Up to 60 functions processed in any combination of sets and groups.

- o Mode-dependent statistics - mean, maximum, minimum, standard deviation, and a ten-level histogram - for each function in a group or for a set of functions.
- o One to four modes specified for any function using AND or OR logic.
- o Displays containing function numbers, function names, modes, statistics, times of occurrence, total number of samples and the histogram values.
- o Data processed in telemetry volts or in engineering units.

3.2.1.6.1.7 Plot Tape Generator (PTG)

Plot Tape Generator shall contain the software necessary to prepare and process data for plotting on a flat bed plotter. This program shall perform the following:

- o Process, format, annotate, and plot up to 80 plots consisting of a series of points taken from a single orbit on a single plotting surface to be performed within a time period of 1.5 hours of plotter time.
- o Provide for axes generation and annotation of up to 80 plots consisting of a series of data points taken from many orbits on a one point per orbit basis on a single plotting surface to be performed within a time period of 1.5 hours of plotter time.
- o Provide capability for extended plots up to 400 orbits per graph.
- o Provide for updating the abscissa (X) axis on a weekly basis.
- o Provide for stacking outputs when plotter is not available.
- o Provide capability to accept data to be plotted by function number.
- o Provide capability to plot function versus function for single orbit points.

3.2.1.6.1.8 Command Verification (CMV)

CMV shall display initial status, orbital profile and terminal status for spacecraft events. It will perform command and mode verification and command and mode prediction. The program shall provide for the following:

- o Determination of event time spans
- o Correlation of the orbital profile changes with commands whose execution time are within the data span.
- o Prediction of event mode changes based on commands sent
- o Determination and display of differences between initial and/or terminal modes and a reference table.
- o Display of initial and terminal modes as a full printout.

Remote sites will return a single-block verification message to the OCC upon receipt of a "good" incoming message, and must report similarly on each "bad" message received. These messages shall indicate either a successful block transmission, or a faulty transmission which will not be processed by the site. Remote sites shall also return a single block status message to the OCC that reports the acceptance and processing disposition of each command message input received. These messages report each successfully completed uplink, or each attempted transmission that was ended prematurely. It shall also report on each message with an obsolete time tag, a duplication of a previously processed message, an input mode violation, or an overlap with a previously-received command message that is still being processed.

3.2.1.7 System Activity Plan and Command Compiler Subsystem

3.2.1.7.1 Performance Requirements

The System Activity Plan and Command Compiler Subsystem shall translate defined spacecraft events into the command sequences that will cause these events to occur. It shall operate only in a non real-time environment and contain no functions required during on-line data acquisition.

The System Activity Plan and Command Compiler Subsystem shall perform the following functions

- Accept payload scheduling and ancillary video data predicted station contact profiles and predicted spacecraft antenna profiles from the DME.
- Generate spacecraft and network scheduling based on payload schedules.
- Generate integrated payload spacecraft and network time-ordered activity events.
- General required commands or command sequences to perform events in the activity plans.
- Separate commands into real-time commands and stored commands.
- Compare time of required activity with predicted orbital acquisition.
- Generate real-time commands for acquisition activities.
- Perform command list optimization process.
- Transfer command list to OCC computer storage.
- Capable of deletion, insertion, and modification of single commands or command sequences.

3.2.1.8 Master Information Control Subsystem

3.2.1.8.1 Performance Requirements

Two computer programs shall be available to provide the mechanism for the development and utilization of mission system data in tabular form.

The Master Information Control Subsystem shall consist of the following:

1. Master Information File Generator (MIFG)
2. Master Information Table Generator (MIFG)

3.2.1.8.1.1 Master Information File Generator (MIFG)

The Master Information File Generator (MIFG) shall maintain the centralized set of files containing spacecraft engineering data. This data provides the basis for the generation of Master Information Tables used by the software application programs. The MIFG shall provide the following functions:

- Maintenance of files on disc storage and magnetic tape.
- Provide the means for creation, additions, changes and deletions to the files by means of input cards.
- Generation of a tape and a listing containing all descriptor and data card inputs separated into sections identifying the files being currently processed.

3.2.1.8.1.2 Master Information Table Generator (MITG)

The Master Information Table Generator (MITG) shall be used to generate a series of tables to be used by the software application programs. The MITG shall perform the following functions:

- Extraction of data from the Master Information File.
- Table generation in the format designated by the using program.
- Storage of the tables generated on disc and magnetic tape.
- Output of table names and file contents to the printer.

3.2.2 RELIABILITY

MTBF and MTTR factors shall be a consideration in the design and selection of CDPF equipment. A Reliability/Maintainability Program shall be implemented in accordance with selected requirements of NPC 250-1 and MIL-STD-470 as defined in GE Document SVS TBD, the R/M Program Plan, which is subject to GSFC approval.

NOTE: The requirement does not apply to the GFE, the NTTF/OCC Interface Equipment, and the NASCOM/OCC Interface Equipment.

3.2.3 MAINTAINABILITY

OCC equipment shall be designed to provide accessibility and replaceability consistent with requirements for maintenance and servicing, testing, fault isolation and repairing.

3.2.3.1 Service and Access

Sufficient access shall be provided to enable visual and manipulative maintenance servicing and test tasks. Access covers are permitted when required and shall be designed for easy removal.

Where access is obtained via sliding, rotating or hinged units, such units shall be free to open or rotate their full distance and remain in their open position without requiring support by hand. Further, the equipment from which such units are extended to reach their open position shall remain stable (i.e., not subject to tipping over) when said units are extended.

3.2.3.2 Installation and Removal

The equipment shall be so designed that it can be easily installed, removed, and re-installed with a minimum of special tools and without extensive disassembly.

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3.2.4 USEFUL LIFE

The equipment shall be designed for an operating life of 15,000 hours over a three-year period following acceptance. Normal maintenance and routine replacement of consumable (known limited life) parts and materials during scheduled maintenance, tune-up and calibration periods shall be permitted.

3.2.5 ENVIRONMENTAL CONDITIONS

Operating and non-operating conditions for the equipment in the OCC are outlined below:

3.2.5.1 Non-Operating Conditions

The equipment shall withstand, and subsequently operate, after exposure to the following environment:

Temperature:	$+20^{\circ}F$ to $100^{\circ}F$
Humidity:	40 to 90%
Vibration and Shock:	As defined in U.S. Govn't Memo, subject "Building 23 Vibration Measurements"

3.2.5.2 Operating Conditions

The equipment shall operate to the requirements of this specification during exposure to the environment below:

Temperature:	$72 \pm 2^{\circ}F$	
Temperature Change:	Δ T=$2^{\circ}F$/30 minutes, maximum	
Humidity:	$50 \pm 5\%$	
Humidity Change:	Δ R.H.=2%/30 minutes, maximum	
Shock and Vibration:	As defined in U.S. Government Memorandum, subject "Building 23 Vibration Measurements"	
Cooling:	Plenum Air Temperature	$60 \pm 5^{\circ}F$
	Blower Outlet Pressure	1.0 ± 0.1 inches of water
	Relative Humidity	$50 \pm 5\%$
	Cooling Flow	(TBD) CFM

3.2.6 TRANSPORTABILITY

OCC equipment shall be installed in Building 23 GSFC. Suitable transportability requirements shall be placed on equipment to assure its safe arrival at Building 23 using commercial transportation and air-ride vans where considered necessary.

3.3 DESIGN AND CONSTRUCTION

The requirements outlined in this section do not apply to equipment identified as commercial "off-the-shelf" equipment. In these cases, S-323-P-5A shall apply.

3.3.1 MATERIALS, PROCESSES, AND PARTS

MS, AN, MIL standard, and commercial materials and parts are acceptable for use in the CDPF. MIL Standard parts usage is preferred.

3.3.2 ELECTROMAGNETIC RADIATION

Control of electromagnetic interference between OCC equipment and equipment interfacing with the GDPF shall be effected in an efficient manner. Since much of this equipment consists of commercial Automatic Data Processing (ADP) equipment, or is equipment designed using commercial logic, a formal EMC program including testing to MIL-Standards is not warranted. However, OCC equipment shall be demonstrated through performance testing to be self compatible at the subsystem or subcontractor level prior to delivery to GSFC for installation and again as a total system at GSFC after installation. EMC problems, if any, uncovered during tests prior to acceptance shall be corrected on an individual basis.

Existance of an EMC problem and determination of its solution adequacy shall be finally determined by a representative specified by NASA.

3.3.3 IDENTIFICATION AND MARKING

All assemblies and subassemblies shall be marked with an identifying number and, if space permits, the manufacturer's identification and component nomenclature. Electrical parts shall be labeled with reference designations in accordance with accepted practices to permit easy identification.

3.3.4 WORKMANSHIP

All CDPF equipment shall be constructed to the highest commercial quality manufacturing standards and workmanship practices, consistent with commercial and design limitations which meet S-323-P-5A requirements as a minimum.

3.3.5 INTERCHANGEABILITY

All printed circuit boards, assemblies, modules, etc. shall be directly interchangeable with like units from the manufacturer. Equipment shall be designed to facilitate replacement of units. Where possible, use shall be made of the same module, assembly, etc., in different parts of a subsystem.

3.3.6 SAFETY

The design and development of the equipment shall provide fail-safe features for safety of personnel during the installation, operation, maintenance, and repair or interchanging of a complete equipment assembly or component parts thereof.

3.3.6.1 Electrical Safety Provisions

1) The design shall incorporate methods to protect personnel from accidental contact with voltages in excess of 30 volts root mean square (rms) or direct current (dc) while operating equipment. Means shall be provided so that power may be cut off while installing, replacing, or interchanging a complete equipment, assembly, or part thereof.

2) Exposure to voltages in excess of 500 volts shall be prevented when cases and seals are removed for maintenance and repair. Equipment access doors or covers shall be provided with interlocks to remove all potential in excess of 150 volts.

3) Equipment shall be designed so that all external parts will be at ground potential. The path to ground for equipment shall be continuous and permanent when connected to facility and the interfacing equipment. Grounding shall be in accordance with SVS TBD Grounding Requirements Specification.

4) Equipment shall be fail-safe in regard to personnel safety, false command generation, and equipment damage during power transients, interruptions, and outages.

3.3.6.2 Mechanical Safety Provisions

The design of the equipment shall be such as to provide maximum convenience and safety to personnel while installing, operating and maintaining the equipment. Suitable protection shall be provided to prevent contact with moving mechanical parts such as gears, fans, and belts when the equipment is complete and operating. Sharp projections on cabinets, doors, and similar parts shall be avoided.

Equipment design shall include provision to prevent accidental pulling out of drawers or rack-mounted equipment components, or inadvertant tipping when pulling out drawers which could cause equipment damage and injury to personnel. Equipment power switches shall be designed and so located that accidental contact by personnel will not place equipment in operation.

3.3.6.3 Temperature Conditions

Where people are involved, and under any condition of operation, exposed parts, including the enclosure of the equipment, shall not achieve a temperature in excess of $140^{\circ}F$ at an ambient temperature of $77^{\circ}F$. The temperature of front panels and operating controls shall not exceed $100^{\circ}F$ at the same ambient temperature.

3.3.6.4 Materials

The materials used in the OCC operations, as well as that in the equipment, shall not create conditions or products which, when combined with the atmosphere or alone are toxic, corrosive, flammable, or explosive and detrimental to the performance of the equipment or health and safety of personnel.

3.3.7 HUMAN PERFORMANCE/HUMAN ENGINEERING

The equipment design shall incorporate human engineering principles and practices to insure that satisfactory performance can be achieved by the operating and maintenance personnel, that skill requirements and training time are minimized, and that the reliability of the personnel-equipment combination are at a maximum.

3.3.7.1 Equipment Configuration

OCC equipment shall be designed to facilitate identification of subassemblies and to protect against improper mounting and installation.

Control panels shall be laid out to provide ease of operation and labeled with titles of non-ambiguity with respect to function. Where practical, protection shall be provided in the OCC against accidental transmission of commands to the satellites.

3.3.7.2 Adjustments

Design of all OCC equipment shall consider human performance parameters in the adjustment methods used.

3.3.7.3 Visual Displays

Visual displays shall provide the operator with a clear and readable (to the granularity needed) indication of equipment or system conditions.

3.3.8 ELECTRICAL

3.3.8.1 Input Power and Regulation

Voltage:	115V ± 10% single phase 208V ± 10% 3-phase, 4-wire
Frequency:	60 Hz ± 2% Δ f=1%/Min.

Note: 3-phase, 5-wire also available.
Separate heavy isolated ground bus will be provided.

3.3.8.2 Balancing of Loads

Equipment using 3-phase power in the OCC shall present balanced loading of ±10% of nominal phase.

3.3.8.3 Utility Bus

OCC equipment shall not be operated from the utility power bus.

3.3.8.4 Grounding

Grounding of all OCC equipment shall be as defined in SVS TBD.

3.3.8.5 Outlets

At least one convenience outlet shall be supplied on each OCC equipment unit.

3.3.8.6 Overload Protection

Fuses, circuit breakers, thermal overload relays, cutouts, etc. shall be used to provide overload protection for primary power circuits on each OCC equipment.

3.3.8.7 Elapsed Time Indicators

An elapsed time indicator shall be provided on power operated equipment to indicate elapsed operating time.

3.3.8.8 Test Points

Units which are not completely self-checking shall be provided with appropriate test points, easily accessible, in standard crimp-on connector or test jack form. The test points provided shall be sufficient to isolate trouble in the equipment down to a removable subassembly.

3.3.8.9 Outages and Interrupts

Emergency procedures for reacting to power outages will be established for the OCC and included in training manuals and exercised preceeding launch. A power outage is defined as a reduction in voltage to less than 90% of nominal.

SECTION 4

QUALITY ASSURANCE PROVISIONS

4.1 GENERAL

A Quality Assurance and Configuration Management Program shall be implemented in accordance with the requirements of NPC 200-3, GSFC S-323-P-5A, and GMI 8040.1 as defined in GE Document SVD TBD. The QA and CM Program Plan is subject to GSFC approval.

The requirements of Section 3 of this specification shall be verified by one or more of the following methods as specified herein.

4.1.1 INSPECTION

The inspection items identified in Section 4.2 shall be verified by an inspection of the equipment to the requirements as specified in applicable engineering drawings, standards, and specifications that result from the detailed design effort. Proper translation of these requirements into the drawings shall be verified through design review and routine design efforts. For those items which cannot be verified by inspection of the fully assembled items, this verification shall be accomplished at the appropriate lower level of assembly.

4.1.2 ANALYSIS

The analysis items identified in Section 4.2 shall be verified by analysis, as defined below:

(1) Reliability - selective MTBF and MTTR analysis shall be conducted to identify potential weaknesses in the design.

4.1.3 DEMONSTRATIONS

The demonstration items identified in Section 4.2 shall be verified by demonstration. These demonstrations shall be continued until approval of performance as specified herein is received by NASA and GE. Nominally, it is intended that all demonstrations will be satisfactorily completed in a scheduled three-month simulation period at GSFC during which all initial maintenance shall also be accomplished.

4.1.4 TESTS

The test items identified in Section 4.2 shall be verified by tests as defined herein.

4.1.4.1 Component or Unit Level Tests

Component level tests shall be conducted to verify compliance with performance requirements established in lower level specifications.

4.1.4.2 Subsystem Level Tests

Subsystem level tests shall be conducted in accordance with GE-SSO and GSFC approved test plans and procedures to verify compliance with performance requirements established in subsystem level specifications.

4.1.4.3 Segment Tests

Compatibility testing and operational testing shall be conducted at the OCC Segment Level in accordance with Segment Test plans and procedures prepared by GE-SSO and approved by GSFC.

(a) OCC Interface Compatibility Testing - Interface Compatibility Testing shall be conducted upon completion of OCC integration. These tests shall be conducted to demonstrate the design compatibility between GDHS technical systems and NASA-GSFC networks.

(b) OCC Operational Exercises - OCC operational exercises shall be conducted to shake down, de-bug, and determine total OCC operational performance under simulated spacecraft launch and mission conditions, including transmission of known simulated spacecraft data tapes from remote stations for processing and display. These known data inputs shall be compared with processed and displayed output data for accuracy.

Operational throughput of the OCC system shall be exercised. These exercises shall also be used to validate all OCC operational procedures for adequacy and accuracy.

4.2 VERIFICATION MATRIX (TBD)

SECTION 5

NOTES

5.1 ACRONYMS

The following table of acronyms is presented for the use of the reader not totally familiar with the EOS CDPF.

ACRONYM	TRANSLATION
ADP	Automatic Data Processing
AOS	Acquisition of Signal
CCT	Computer Compatible Tape
C&DD	Communications and Data Distribution
CDPF	Central Data Processing Facility
CIEU	Computer Interface Equipment Unit
CMP	Command Management Program
CMV	Command Verification Program
CP	Communications Processor
CPU	Central Processing Unit
CRT	Cathode Ray Tube
DCS	Data Collection System
DECOM	Communications Processing Subsystem
DIOD	Direct Input/Output Distributor
DLP	Data Listing Program
DME	Data Management Element
DTS	Data Transmission System
EMC	Electromagnetic Compatibility
EOS	Earth Observatory Satellite
GAP	General Averages Program

ACRONYMS	TRANSLATION
GDHS	Ground Data Handling System
GMT	Greenwich Mean Time
GSFC	Goddard Space Flight Center
GST	Ground Station Time
HRPI	High Resolution Pointable Imager
ICD	Interface Control Document
I/O	Input/Output
IPE	Image Processing Element
IOP	Input/Output Processor
Kbps	Thousand-bits-per-second
KBD	Keyboard
LOS	Loss of Signal
Mbps	Million-bits-per-second
MIF	Master Information File
MIFG	Master Information File Generator
MIT	Master Information Table
MITG	Master Information Table Generator
MMEV	Memory, Matrix, and Emergency Mode Verify
MSS	Multispectral Scanner
MTBF	Mean-Time-Between-Failure
MTTR	Mean-Time-To-Repair
MTU	Magnetic Tape Recording Unit
M&O	Maintenance and Operation
NASCOM	NASA Communications Network
NTTF	NASA Test and Training Facility

ACRONYMS	TRANSLATION
OCC	Operations Control Center
ODG	Orbit Determination Group
OFPAS	Off-Line Processing and Analysis Subsystem
OLS	Off-Line Supervisor
ONPAS	On-Line Processing and Analysis Subsystem
PAS	PCM Acquisition Supervisor
PCM	Pulse Code Modulation
PTP	Playback Telemetry Processing Package
RAD	Rapid Access Disc
RDT	Raw Data Tape
RGP	Report Generator Package
RGS	Report Generator Supervisor
R/M	Reliability/Maintainability
RMS	Root Mean Square
RT	Real-Time
RTP	Real-Time Telemetry Processing Package
S/C	Spacecraft
S/S	Subsystem
SC&D	Status Control and Display
SCASU	Signal Conditioning and Switching Unit
SCEST	Statistics, Controls, Evaluation, Stock and Thermal
SCE	Spacecraft Command Encoder
SIRD	Support Instrumentation Requirements Document
STDN	Spaceflight Tracking and Data Network

ACRONYMS	TRANSLATION
SUBD	Subsystem Display
TBD	To Be Determined
TBR	To Be Resolved
TDRSS	Tracking and Data Relay Satellite System
TLM	Telemetry
TM	Thematic Mapper
TMV	Telemetry Volts
TSD	Time Slot Display
TT&C	Tracking Telemetry and Command
TTY	Teletype
WBDSC	Wide-Band Data Set Coupler